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PERSONALIA

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Aleksandr Fedorovich Andreev (on his sixtieth birthday)

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Academician Aleksandr Fedorovich Andreev, an outstanding theoretical physicist, eminent scientist and one of the leading figures governing the Russian Academy of Sciences, was 60 on December 10, 1999.

Soon after A F Andreev's birth in Leningrad, his family moved to Moscow where he entered Moscow Physical-Technical Institute in 1956. He started his scientific carrier in 1959, soon after his bizarre handling of the so-called theoretical minimum offered by L D Landau to the ablest students before they came to work with him. L D Landau immediately recognized the remarkable faculties of his pupil and advised him to complete the academic curriculum ahead of the time-schedule which A F Andreev did and graduated from the institute earlier than his fellow-students (1961).

On graduation, he joined the staff of the Institute for Physical Problems to which he has maintained life-long, unwavering devotion and loyalty. The very first results obtained by A F Andreev were soon highly appreciated by P L Kapitza, patriarch of Russian physicists, who headed the institute at that time. During his early years at the institute, A F Andreev was surrounded by such notable theorists as E M Lifshits, I M Khalatnikov, A A Abrikosov, L P Gor'kov, I E Dzyaloshinskiĭ, L P Pitaevskiĭ and brilliant experimenters (A I Shal'nikov, A S Borovik-Romanov, Yu V Sharvin, N E Alekseevskiĭ, M S Khaĭkin, to mention but a few). A F Andreev acquired from his senior colleagues the sense of priority of basic science, the serious and honest attitude to work.

The most valuable quality of A F Andreev's works is the wealth of fundamental ideas which gave incentive to the development of many branches of modern physics. They include, in the first place, such areas of condensed-matter physics as superconductivity, quantum fluids and solids, magnetism, surface physics, and mesoscopic phenomena. A F Andreev is also reputed for breakthroughs in other fields of physics, e.g. hydrodynamics, the theory of elasticity, optics, and gravitation theory.

In one of his early works, A F Andreev suggested the idea of a totally new and very unusual type of reflection of the conduction electron from the interface between a normal metal and superconductor. Since then, this phenomenon known as 'Andreev reflection', has been described in the majority of textbooks on solid-state physics. It consists in that an electron coming to the interface from the side of the normal metal gives rise to a Cooper pair in the superconductor while the current continuity at the interface is maintained due to electron conversion into a hole which moves following the electron's time-inverted trajectory. This idea explained a number of anomalous features in the intermediate state of superconductors. Subsequent studies demonstrated that Andreev reflection (and its analogues) in low-temperature physics is a rule rather than the exception; it is inherent not only in electron excitations but also in other quasi-particles in a large variety of physical systems. This 'purely theoretical' result has important practical implications. Andreev reflection is widely employed in the so-called Andreev interferometers and modern highly selective radiation detectors. Its spectrum of application may be further extended with the progress of electronics.

Aleksandr Fedorovich Andreev

In a classical study performed jointly with I M Lifshits, A F Andreev formulated the fundamental concept of quantum crystals as a new class of solids with an abnormally large amplitude of zero point motion responsible for a number of qualitatively new effects. Point defects in quantum crystals, such as vacancies and impurities, are delocalized and behave as quasi-particles, each having a specific energy spectrum. As a result, the crystal acquires very unusual properties of which the most characteristic example is the

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so-called 'quantum diffusion'. In co-authorship with A Ya Parshin, A F Andreev suggested the idea of non-dissipative growth and melting of quantum crystals and predicted a new type of crystal surface oscillation, the so-called crystallization waves. The results of these and a series of subsequent works were definitively confirmed by experiments in many of the world's laboratories and gave added stimulus to the development of a new rapidly progressing discipline, the physics of quantum crystals.

A F Andreev made a fundamental contribution to the theory of magnetism. He proposed (jointly with V I Marchenko) a classification of symmetric and dynamic properties of magnetics which consistently takes into account exchange and weaker relativistic interactions. Also, he gave an elegant physical description of a new class of ordered materials, magnetic analogues of liquid crystals. Another impressive discovery by A F Andreev was that of magnetic polarons arising from quantum vacancies in solid helium-3. This discovery was made long before the phenomenon became a popular subject of research concerned with the mechanisms of high-temperature superconductivity. A series of fundamental works by A F Andreev are devoted to surface physics. They include the development of the theory of helium-3 and helium-4 surface states (known as 'Andreev states'), conceptual aspects of the theory of facet origination in crystals, the Kapitza resistance theory, and surface phenomena in metals and antiferromagnetics.

Not all the lines of research greatly promoted by A F Andreev can be listed in such a brief account as this. Suffice it to note that his latest studies have been focused on the physical properties of mesoscopic systems such as ultracold gases in magnetic traps and metallic nanoscale particles (mesoscopic quantum dots). A F Andreev described the very peculiar nature of superfluidity, superconductivity, and magnetism at the mesoscopic level. It turned out that an adequate description of mesoscopic superconductivity is possible in the framework of the superspace concept used in modern supersymmetric field theories. Experimental verification of the superconducting and magnetic properties of nanoparticles described by A F Andreev with a large arsenal of up-to-date technical facilities would provide, if successful, a direct confirmation of the superspace concept. Hence, the fundamental epistemological significance of the problem.

L D Landau was always the highest scientific authority for A F Andreev and remains so now. Working in the style of his teacher which he accepted from the outset of his carrier in science, A F Andreev has demonstrated extensive knowledge of theoretical physics as an integrated scientific discipline, an urge toward understanding the genuine simplicity and unity of physical laws, an ability to formulate fundamental questions at the phenomenological level, and an unconcealed dislike of pretentious models and cumbersome calculations. These are the most distinctive personal qualities displayed by A F Andreev as a scientist. His summings up and judgments are models of conceptual clarity and technical economy, even when he brings to science a most daring range of ideas. All his works including purely theoretical ones are in the end addressed to experimenters and give additional impetus to innovative research.

A F Andreev's achievements have been recognized both in this country and abroad. He was given the distinction of election to the USSR Academy of Sciences, first as a corresponding (1981) and then full member (1987). He is also a member of the American Physical Society. He was awarded the Lomonosov Prize (1984) and Lenin Prize (1986), the Carus Medal and the Prize of the Deutsche Akademie der Naturforscher Leopoldina (1987), the Simon Memorial Prize (1995), and the Kapitza Gold Medal (1999). He was given honours by the Russian government including the 3rd class Order for Merit. A F Andreev is the honorary Lorentz professor at Leiden University and an honorary member of the A F Ioffe Physical-Technical Institute, Russian Academy of Sciences. Having his reputation as a public figure maintained at its highest, A F Andreev discharges many civilian functions. He sits on the President's State Honours Commission and is the Vice-Chairman of the President's Commission on State Prizes.

In 1984, A F Andreev was appointed Assistant Director and in 1990 promoted to Director of the Institute for Physical Problems (IPP), Russian Academy of Sciences. In 1991, he was elected Vice-President of the Academy. He is also a member of the Bureau of the Division of General Physics and Astronomy, RAS, and chairs the Council on Low-Temperature Physics of RAS. A F Andreev is always considerate to his subordinates and thoughtful of their needs. But, being a foe of compromise, he can just as well impress by sincerity and deep regard for scientific truth in the critical examination of the works of his fellow scientists, age and station notwithstanding. He gives immense moral encouragement to scientists who left the institute to work abroad, helps them to keep in touch with IPP and thus remain true to its traditions. It is therefore appropriate to say that A F Andreev has managed to set up several affiliated centres of IPP based in the world's leading physical laboratories. Moreover, he maintains personal contacts with these researchers as the Chairman of the Scientific Council of the International Institute of Strong Magnetic Fields (Wroclaw) and a member of the Governing Scientific Council at the International Centre of Theoretical Physics (Trieste).

Carrying an enormous burden of administrative work, A F Andreev enjoys the practice of scientific research more than anything else. The joy of creation and a strong belief that basic studies will eventually bring the desired fruits help him to avoid squandering energy and time and to gain much by concentrating on the most important objects. He is a frequent lecturer at scientific seminars, and his presentations and comments are models of lucidity presented in a manner calculated to make the essentials of his work understandable to a broad audience of students and other listeners. He is always ready to discuss his and his colleagues' works, being easily accessible to anyone who needs his advice to verify a new physical idea, no matter how vague it may be. He has a rare gift for marshalling facts to the issues to which they are relevant, and his opinion on countless points is held in high esteem both at the institute and elsewhere.

Teaching remains one of the central interests of A F Andreev to which he devotes much of his time and energy. He is professor at the Moscow Institute of Physics and Technology where he holds the Chair of Low-Temperature Physics and heads the Coordinating Council. In line with the tradition established by P L Kapitza, he himself gives examinations to determine the progress of all postgraduates continuing education and pursuing research at IPP and takes much care to have each gifted young person grow into a full-fledged scientist. He prefers working with his pupils on an individual basis; many of them have become well-known in the physical world. Teaching has naturally led A F Andreev to doing editorial work and publishing. In 1993, he became

Editor-in-Chief of the scientific and popular magazine *Priroda* (Nature). Since 1997, he has been the Editor-in-Chief of *Zh. Eksp. Teor. Fiz.* (Journal of Experimental and Theoretical Physics — *JETP*), one of the most prestigious Russian physical journals.

A F Andreev celebrates his sixtieth birthday full of vigour, new plans and ideas. We cordially wish him new achievements in his many and varied scientific and managerial endeavours.

Zh I Alferov, A A Boyarchuk, V L Ginzburg,
A M Dykhne, V E Zakharov, Yu M Kagan,
L V Keldysh, Yu A Osip'yan, A Ya Parshin,
L A Prozorova, A N Skrinskiĭ, I M Khalatnikov